L A N D S A T　　　　　　**D a t a   C o n t i n u i t y   M i s s i o n**

LDCM

LANDSAT DATA CONTINUITY MISSION

LDCM Project Reference Database System (PRDS) to Users

Data Format Control Document (DFCD)

December 16, 2007

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

CM FOREWORD

This document is a Landsat Data Continuity Mission (LDCM) Project Configuration Management (CM)-controlled document. Changes to this document require prior approval of the applicable Configuration Control Board (CCB) Chairperson or designee. Proposed changes shall be submitted to the LDCM CM Office (CMO), along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

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1.　INTRODUCTION

1.1　PURPOSE

The purpose of this document is to define the requirements and control the data format for the Landsat Data Continuity Mission (LDCM) Project Reference Database (PRD) interface to LDCM users and LDCM systems that use information from the PRD.

1.2　SCOPE

The provisions of this document apply to the data interface between the central PRD, which is maintained by the Flight Operations Configuration Control Board (CCB) at the LDCM Mission Operations Center (MOC), and all LDCM PRD users.. The document defines the types of content to be configured in the PRD and a common format for storage of PRD master copies. This document will also provide translation definitions between the LDCM PRD content and those items in altenate formats from external users.

Note that defining the content for this Data Format Control Document (DFCD) is an on-going effort and more types will be added in the future. This DFCD does not define actual PRD data. In addition, the user interface to the MOC PRD System (PRDS), is not addressed in this document.

This document is intended to be maintained through the entire lifecycle of the LDCM PRD, which begins with the use of the PRD in LDCM development and continues through the operations phase of the mission.

1.3　MISSION OVERVIEW

This section is not intended to describe functionality or requirements of the LDCM ground system applications or PRDS. It provides a brief description of the LDCM ground system and illustrates the PRDS role in the construction and management of its databases. Reference the LDCM Operations Concept Document (GSFC 427-02-02) for further details.

1.3.1　Overview of the LDCM Ground System (GS)

The GS is comprised of an integrated system of elements and interfaces to external support elements. The segments comprising the GS include the Flight Operations Segment (FOS) and the Data Processing and Archive Segment (DPAS). The FOS elements include the Mission Operations Element (MOE), Collection Activity Planning Element (CAPE), and Ground Network Element (GNE). DPAS elements are the User Portal Element (UPE), Storage & Archive Element (SAE) Image Processing Element (IPE) and Infrastructure Element (IE). In addition to the CAPE, the MOE interfaces with the GNE and IE.
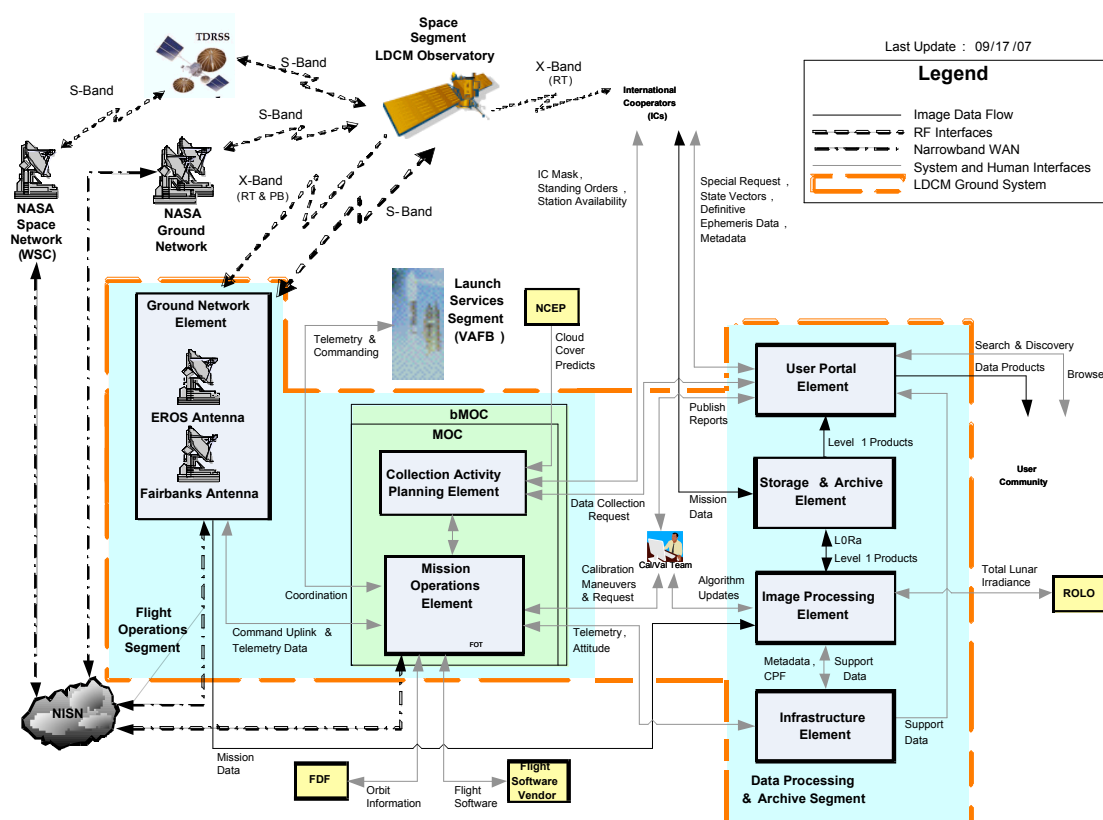
Figure 1-1 – LDCM Ground System context

1.3.2   Mission Operations Center (MOC) Overview

Each of the MOC facilities (primary and backup) provide a system of applications and interfaces to external support elements sufficient to meet mission objectives. Major elements integrated into the MOC environment include the MOE and CAPE. This system interfaces to the User Portal Element (UPE), Ground Network Element (GNE), Infrastructure Element (IE), LDCM Project Reference Database (PRD) system and institutional services provided under the Project Service Level Agreement (PSLA). Institutional services include voice and data network support, the NASA Ground Network (GN), Space Network (SN) and the NASA Flight Dynamics Facility (FDF). Figure 1-2 provides a context for the MOC and its interfaces.
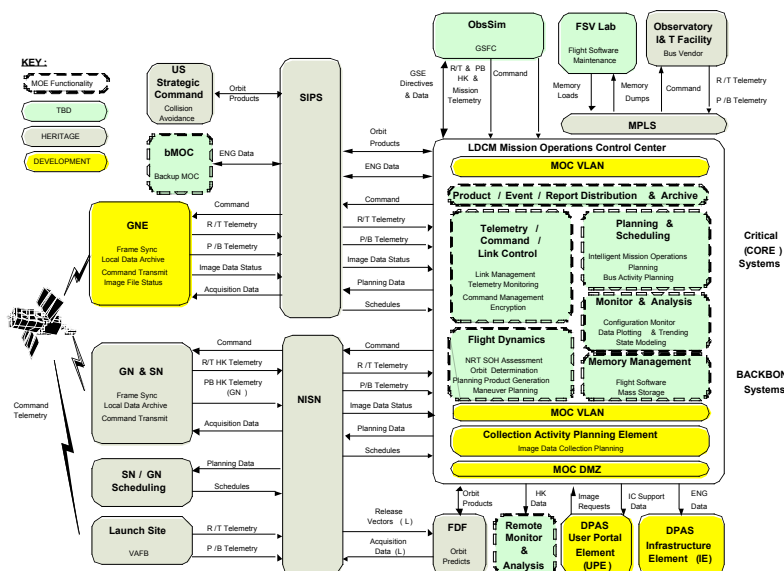
Figure 1-2 – LDCM MOC context

The MOC internal network is government supplied and designed to provide secure access to support elements hosted on a variety of networks. Figure 1-1 above provides a high level notional view of the network services available.

Utilization of the Controlled Repository

This section is intended to illustrate the MOCs role in controlled operational data distribution and maintenance.

The MOC will generate, distribute, archive and provide access to project reference data. This data satisfies the needs of a diverse LDCM community ranging from ground system applications to remote users such as NASA/USGS/vendors and off-site FOT. Access to this data is provided from several networks but is always controlled. The Controlled Repository function simplifies this operation, maintains the integrity of the available data, distributes the data, synchronizes the distributed data files, and provides data access where needed. The repositories are redundant in the MOC, available in the back-up MOC (bMOC) with an instance maintained on the open network to facilitate access by remote authorized users, applications on the open networks and to initialize a bMOC cold-start. At a minimum, the repositories contain a copy of the Project Reference Database (PRD).

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1.3.3   The Project Reference Database (PRD) system

This section is intended to illustrate the PRD role in the overall database process and elaborates on the related interfaces.

The PRD is maintained by a standalone system (PRDS) which supports configuration management of all ground system data administered by the Flight Operations Configuration Control Board. The system is a government provided set of utilities used to collect, control and distribute configuration managed data across ground system applications. The system will generally be co-located with the Controlled Repositories and mini-MOE sites.

The PRD is a file containing all the configured data used to develop, test, and operate the Observatory, as well as some of the metadata needed to manage the PRD. The master PRD zip file is distributed across the Controlled Repositories of the MOC. The term "configured data" is understood to include all application system databases and FOT Products under control of the Flight Operations CCB. Dynamic data such as actual telemetry, as well as any static data used in LDCM flight or ground software without configuration control through the Flight Operations CCB, are not considered configured data. The PRDS and master PRD database is administered under the office of the PRD Management Office (MO).

Input and output to the PRD is in the format native to the application. The PRD system will perform any necessary translations from the native application format to the CCSDS compliant XML Telemetric & Command Exchange PRD format.

The PRD content is distributed across a wide, geographically dispersed network of LDCM development sites.

Some of the key user sites are shown in Figure 1-3 below.

- Spacecraft Integration & Test (I&T) facility (a mini-MOE site)

- Instrument Development & Test (D&T)lab (a mini-MOE site)

- MOC (Primary and Redundant Controlled Repository)

- bMOC (backup Controlled Repository)

- Remote Mission Monitor and Analysis System (Open Controlled Repository)

- Flight Software Vendor (a stand-alone PRD system)

PRD Notional Deployment
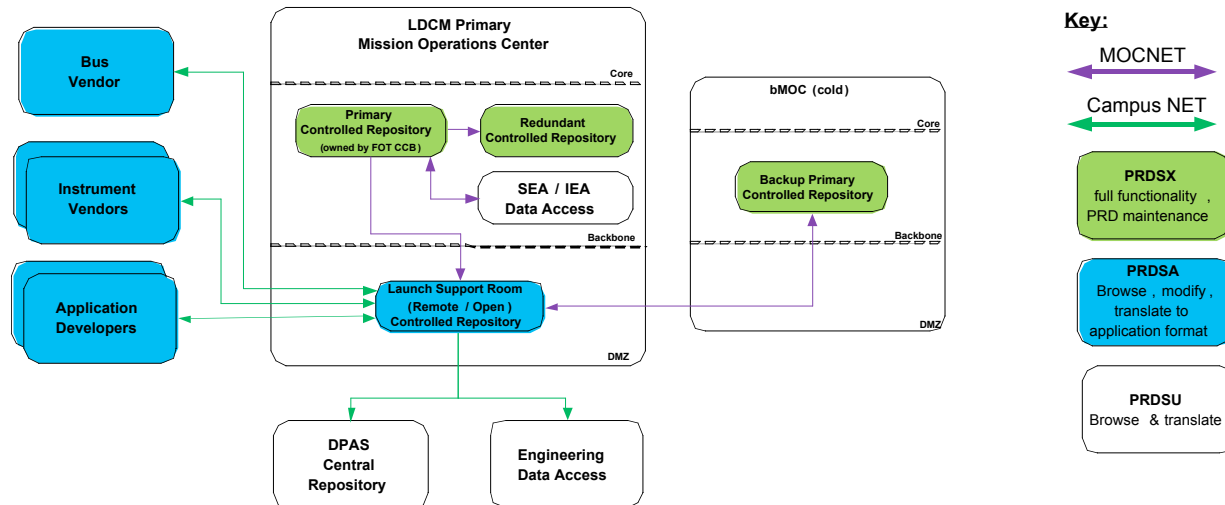
Figure 1-3 – LDCM Project Reference Database (PRD) System Notional Deployment

The PRDS toolkit software allows users to contribute content to the PRD consistent with the DFCD.

1.4   DOCUMENT ORGANIZATION

Section 1 specifies the purpose, scope, and content of this document and specifies references to other documents that contain relevant material.

Section 2 provides a list of applicable and reference documentation.

Section 3 provides a high-level description of the interface and a set of high-level requirements on the interface.

Section 4 describes the organization of the PRD and the procedures for user sites to access PRD Releases made available by the Flight Operations CCB.

Section 5 defines the logical format of each type of PRD content listed in Section 3. This defines all valid data elements together with a description of the purpose of each element, data validity rules (data structure, data class, range limits, etc.), and any constraints between elements. This section defines the structures inherent to the version of the PRD developed for another GSFC mission. LDCM will use or not use these construct, as necessary. When needed to support LDCM, additional XTCE-compliant data types will be added to the definition.

Section 6 defines the detailed formats needed to support interface requirements listed in Section 3. This defines all valid data elements together with a description of the purpose of each element and data validity rules (data structure, data class, range limits, etc.). This section is designed to

draw the relationship between PRD and application native data fields and defines any necessary translation between the two databases.

Appendix A defines the abbreviations used in this document.

Appendix B defines the data dependency rules employed by the PRDS Cross-Referencing System (XREF).

2.   DOCUMENTS

2.1   APPLICABLE DOCUMENTS

The following documents provide information used to define the content of this DFCD.

Document Number	Revision/ Release Date	Document Title
427-09-03	Draft December, 2007	LDCM Mission Operations Element Requirements Document
427-01-05	Baseline November 30, 2007	Landsat Data Continuity Mission (LDCM) Configuration Management Procedures
GSFC STD-1000A Revision A 2005-05-30	Rev C.2 December 12, 2006	Rules for the Design, Development, Verification and Operation of Flight Systems
NPD 8010.2E	March 04, 2007	NASA Policy Directive, Use of the SI (Metric) System of Measurement in NASA Programs
CCSDS 660.0-M-0.0	Draft October, 2007	Draft Report Concerning Space Data System Standards XML Telemetric & Command Exchange.

2.2   REFERENCE DOCUMENTS

The following documents provide further context for the DFCD and the LDCM.

Document Number	Revision/ Release Date	Document Title
427-02-06	Draft November 2006	LDCM Acronym List and Lexicon
427-02-02	January 4, 2007	LDCM Operations Concept Document
CCSDS 231.0–B–2	September 2003	Recommendation for Space Data Systems Standards. TC Synchronization and Channel Coding. Blue Book. Issue 1.
CCSDS 231.0–B–1 Cor.1	June 2006	Recommended Standard Technical Corrigendum 1 to CCSDS 231.0-B-1, Issued September 2003. Blue Book. Issue 1.
CCSDS	September	Recommendation for Space Data Systems

232.0–B–1	2003	TC Space Data Link Protocol. Blue Book. Issue 1.
CCSDS 232.1–B–1	September 2003	Recommendation for Space Data Systems Standards. Communications Operations Procedure-1. Blue Book. Issue 1.
CCSDS 133.0-B-1	September 2003	Recommendation for Space Data Systems Standards TM Space Packet Protocol. Blue Book. Issue 1.
CCSDS 131.0-B-1	September 2003	Recommendation for Space Data Systems Standards TM Synchronization and Channel Coding
CCSDS 732.0-B-1	July 2006	Recommendation for Space Data Systems Standards AOS Space Data Link Protocol

2.3 DOCUMENT FLOW DOWN

The DFCD will customize the existing data type definitions as needed to ensure applicability to the LDCM project. The DFCD will also define
- Additional LDCM related data types consistent with the CCSDS XTCE standard.
- Translation tables that will explain the correspondence between native and foreign (i.e., those provided by outside sources) data type fields.

The following document tree (Figure 2-5) shows the flow down for this specification from the Ground Segment Requirements Document and Flight Observatory to the LDCM DFCD.
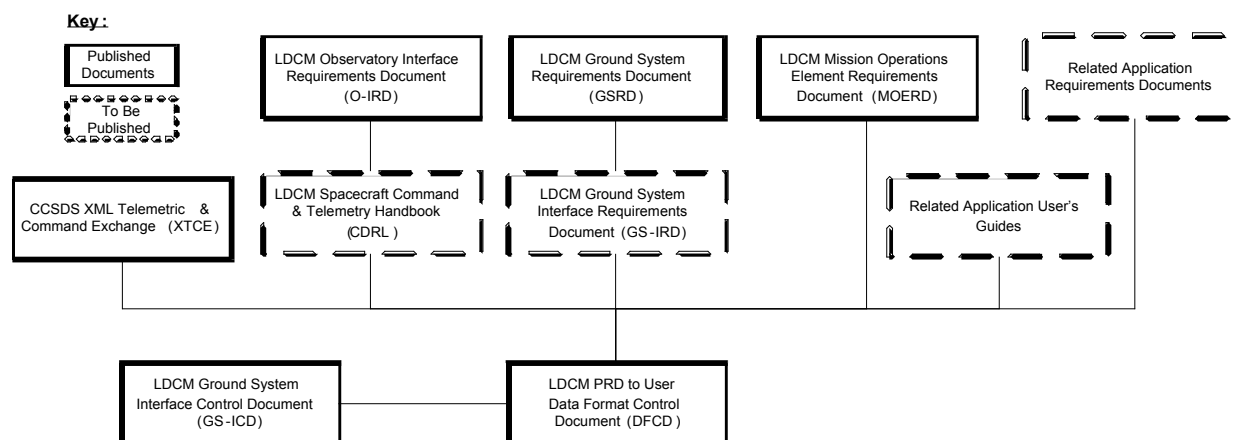
Figure 2-5 – LDCM Data Format Flow

2.4 DOCUMENT TERMINOLOGY

The following terms may be used internal to requirements in this document:
The term "shall" indicates a requirement - a specification of a function, capability, or constraint with which the system design must be compliant, verifiable and have a demonstrated achievement during the mission.

The term "(TBS)", which means "to be specified", means that the spacecraft, instrument or other ground system element contractor will supply the missing information in the course of the contract. These serve as a placeholder for future requirements. The MOE contractor is not liable for compliance with these "placeholder" requirements, as insufficient information is provided on which to base a design.

The term "(TBR)", which means "to be refined/reviewed", means that the requirement is subject to review for appropriateness by both contractor and the government, and subject to revision. The MOE contractor is liable for compliance with the requirement as if the "TBR" notation did not exist. The "TBR" merely provides an indication that the value is more likely to change in a future modification than requirements not accompanied by a "TBR".

3.   INTERFACE DESCRIPTION

A centralized PRD repository, natively stored in the format described in this DFCD, provides a single interface to achieve the following goals:
- Reduces, by means of its compliance with the CCSDS XTCE standard, costs associated with desperate database items stored in proprietary formats.
- Reduces the time associated with scheduling of database and application updates.
- Allows a commonality of database field interpretation across the applications.
- Fulfills a majority of the LDCM Flight Operations configuration management requirements of database items for its contributors and users.
- Assures integrity of controlled products throughout the LDCM project and helps establish a reliable interface to modify PRD content.

3.1   PRD SCOPE

The LDCM PRD contains all configured data used to develop, test, and operate the Observatory, as well as some of the metadata needed to manage the PRD. The term "configured data" is understood to mean all FOS databases and FOS-related FOT Products under control at the Flight Ops CCB level (Level IV). Dynamic data such as proposal data and actual telemetry, as well as any static data used in LDCM flight or ground software without configuration control through the Flight Operations CCB, are not considered configured data.

3.2   PRD APPLICATION INTERFACES

Some of the anticipated user sites are shown in Figure 3-1 and listed below.

Space Segment (SS)
- Spacecraft Integration & Test (I&T) facility (a mini-MOE site)
- Instrument Development & Test (D&T)lab (a mini-MOE site)
- Flight Software Vendor (FSV)

Ground System (GS)
- MOC (Primary and Redundant Controlled Repository)
- bMOC (backup Controlled Repository)
- Remote Mission Monitor an Analysis System (Remote Controlled Repository)
- MOE Developer
- Observatory Simulator Developer

LDCM PRDS Interfaces
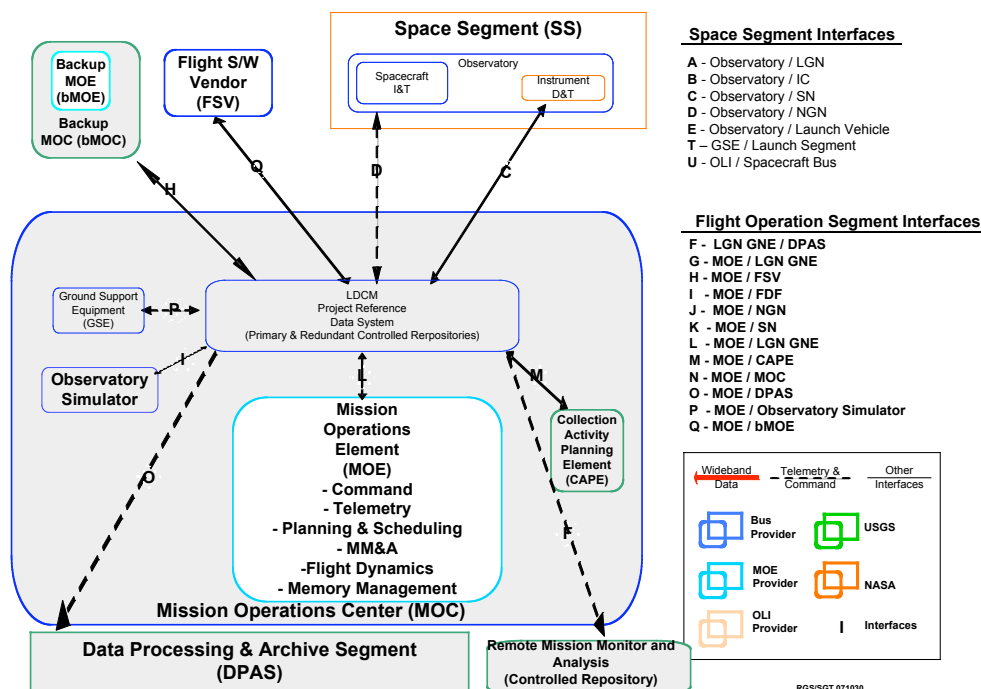
Figure 3-1. PRD Interface Diagram

While the list of entities contributing to the PRD has yet to be determined, a probable list follows:

User's	Applications
Spacecraft Integration & Test (I&T)	mini-MOE (TBR)
Instrument Development & Test (D&T)	mini-MOE (TBR)
Flight Software Vendor (FSV)	(TBS)
Mission Operations Center (MOC)	MOE (TBR)
Backup Mission Operations Center (bMOC)	MOE (TBR)
Remote Mission Monitor an Analysis System	MOE (TBR)
MOE Developer	MOE (TBR)
Observatory Simulator Developer	(TBS)

For more background about the MOE functions contributing to the PRD, see the LDCM Project Mission Operations Element Requirements Document (427-09-03).

3.3   PRD DATA MODEL

The PRD is a collection of content units called **data items**. Data items are considered atomic, in that they can be added to, replaced in, or deleted from the PRD only as a unit. A data item is composed of one or more **elements**, which are individual fields or composite records. A data item belongs to a metaclass called a **data type**, which contains a governing schema for valid content of that type. The schema for a data type enables automatic verification of any data item of that type. In the PRD architecture, each data item is stored as a separate file.

Data items within the PRD are organized first by data type and then by LDCM subsystem. Subsystems refer to units within the observatory and ground systems, including instruments (e.g. OLI), spacecraft subsystems (ACS), ground system software elements (MOE, etc) and larger scale element functional applications (FD, etc). For illustrative purposes, a notional instrument command "SelectOLICAMFilter" would belong to the **Command** data type and the OLI subsystem.

3.4   INTERFACE REQUIREMENTS

3.4.1   Electronic Communications

PEI-10: The PRD interface shall support electronic exchange of data files between the Flight Operations CCB and user sites.

3.4.2   PRD Data Types

PEI-11: The PRD interface shall support the exchange of all data types listed in Table 3-1. The storage format for each data type is specified within this DFCD. Data supplied as input to the PRD in the specified format becomes available for retrieval exactly as supplied via published PRD releases. Translation utilities provided by the PRD MO can be used to translate data into other formats as needed to support LDCM Project requirements.

3.4.3   Data Transport Directory Structure

PEI-14: The PRD interface shall support the exchange of data according to the Data Transport Directory Structure listed in Table 3-2 and Table 3-3.

3.4.4   Standards for Engineering Units

PEI-12: All engineering units defined in PRD definitions shall be compliant with NPD 8010.2E.

3.4.5   PRD Change Requests

PEI-13: The PRDS interface shall support the submission of change requests for PRD data to the Flight Operations CCB.

3.4.6   PRD Certification Packages

PEI-15: The PRDS interface shall support the submission of certification packages for PRD data to the Flight Operations CCB.

3.4.7   CVS Files

PEI-16: The PRDS interface shall not allow any file or directory named cvs (any case). This is a reserved word in the PRDS Version Control System.

Table 3-1. PRD Data Types

#	Data Type	Description	Format
1	Commands	Individual command definitions and attributes	XML
2	Telemetry Definitions	Individual telemetry definitions and attributes	XML
3	Packet Definitions	Characteristics of telemetryand command packets	XML
4	Conversions	Conversion coefficients for telemetry and commands	XML
5	Database version name	Unique Name of a collection of data type instances	XML
6	Subsystem list	List of Subsystems used by LDCM	XML
7	Real-time Procedures	Individual scripts used by LDCM ground system (GS)	Non-XML text
8	System Displays	Informational pages used by LDCM ground system	Non-XML binary
9	Workspaces	Desktop designs used by LDCM ground system	Non-XML binary
10	Display Templates	Definition of system structures for displays	XML
11	Display Pages	Formats for a particular LDCM GS display page	XML
12	OBP FSW Definitions	Definitions of memory regions for onboard processors	XML
13	OBP Memory Load Templates	Templates for loading data into onboard processors.	Non-XML text
14	Command APID Description	APID Descriptions for memory load reports	XML
15	FOT FSW Tables	Defined values for FOT tables	XML
16	FSV FSW Tables	Defined values for Flight Software Vendor tables	XML
17	Derived Telemetry	Algorithms for modifying telemetry	Non-XML text
18	Ground System Data Definitions	Ground version of Telemetry definitions – system parameters	XML
19	ATS / RTS Definitions	Onboard processor stored sequence definitions	XML
20	EGSE Directives	Electrical Ground Support Equipment directive (command) definitions and attributes	XML
21	EGSE Telemetry Definitions	Electrical Ground Support Equipment telemetry definitions and attributes	XML
22	EGSE Scripts	Electrical Ground Support Equipment procedures	Non-XML text
23	Group Permissions	Group permissions available for permission checking	XML
24	User and Workstation Permissions	User and Workstation permissions to control group permissions	XML

Note: This is a representative list and is not complete. Modifications to these and additional data types will be defined in subsequent versions of this DFCD.

Table 3-2. PRD Data Transport Directory Structure (Primary)

ROOT	LEVEL – 1	LEVEL - 2	LEVEL – 3
	[CmdXML]	SubDirectories(1)	DataItem(s)
	[TlmXML]	SubDirectories(1)	DataItem(s)
	[PktXML]	DataItem(s)	
	[ConvXML]	SubDirectories(2)	DataItem(s)
	[VersionNameXML]	DataItem	
	[SubsysXML]	DataItem	
	Real-time Procedures	DataItem(s)	
	[SystemDisplay]	DataItem(s)	
	[WorkSpaces]	SubDirectories(2)	DataItem(s)
	[DispTemplatesXML]	DataItem(s)	
	[DisplayPagesXML]	SubDirectories(2)	DataItem(s)
	[OBP_DefXML]	DataItem(s)	
	[OBP_MemLoadTemplates]	DataItem(s)	
	[CmdAPIDXML]	DataItem(s)	
	[FOTTblXML]	DataItem(s)	
	[FSVTblXML]	DataItem(s)	
	[DerivedTLM]	DataItem(s)	
	[GDPXML]	DataItem(s)	
	[ATSRTSDefXML]	SubDirectories(1)	DataItem(s)
	[EGSEDirXML]	SubDirectories(3)	DataItem(s)
	[EGSETlmXML]	SubDirectories(3)	DataItem(s)
	EGSE Scripts	DataItem(s)	
	[GroupPermXML]	DataItem(s)	
	[UserWorkPermXML]	DataItem(s)	
	[Reports]	*ReportFile(s)*	
	[Utilities]	*[forms], [macro_tools] [schema], [templates], [xref]*	*UtilityFile(s)*

Table 3-3. PRD Data Transport Directory Structure (Secondary)

Secondary SubDirectory Structures			
	SubDirectories(1)	**SubDirectories(2)**	**SubDirectories(3)**
	[ACS]	[Spacecraft]	[DPAS_IE]
	[CDH]		[DPAS_UPE]
	[EPS]		
	[TCS]		
	[COMM]		
	[PROP]		
	[STRUC]		
	[FSW]		
	[OLI]		
	[GSE]		
	[GSE_CAPE]		
	[GSE_MOE]		
	[GSE_MOE_FD]		
	[IGS]		

Note: This is a representative list and is not complete. Modifications to these and additional directory structures will be defined in subsequent versions of this DFCD.
This Structure will be adjusted to accommodate any additional data types specified in Section 3.4.2.

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4. <u>PRD REPRESENTATION</u>

4.1 PRD STRUCTURE

The PRD is composed of files organized primarily by **data type** (e.g., commands, telemetry definitions, etc.), then secondarily by **subsystem** (e.g., power, communications, etc.) as displayed in Table 3-3. For example, one set of files might consist of 200 individual power commands (each in its own file); another set could comprise several files specifying the characteristics of the Observatory's instrument. There are some data types such as Packets and Database Version Name that are global in nature and are not subdivided by subsystem. This organizational structure facilitates tracking of individual changes, assurance of certification completeness, and the construction of a specific aggregation of files for a specific purpose. A specific aggregation is referred to as a **version** of the PRD repository. A PRD version has a unique name and could consist of a few data types for early testing or a complete set of all data types and all subsystems for post-launch operations.

Naming conventions for PRD files depend on the data type and are specified in the introductions to each data type in Section 5.

4.2 PRD ACCESS PROCEDURES

PRD versions authorized by the Flight Operations CCB are assembled by the PRD MO, released to the Primary Controlled Repository and subsequently pushed to the remaining repositories. There it is made available for downloading by authorized PRD users.

The aggregation of files that constitutes a PRD version is organized into directories and subdirectories following the structure discussed above. The PRD version will be packaged into a single compressed file, which is published on the Controlled Repositories. Authorized PRD users electronically access these secure servers through a two-factor authentication interface. The servers will show the current and previously published PRD versions, easily differentiated by the unique names. After the compressed file is retrieved, it may be unpacked into its constituent parts through widely available public-domain software. This replicates the hierarchical file structure of the PRD.

LDCM project personnel may become authorized PRD users through application for a PRD account through the PRD MO.

4.3 XML INTERFACE DESCRIPTION

Some data types defined in this DFCD are represented in the Extensible Markup Language (XML). An XML file (or "document") consists of a collection of **elements** arranged into a hierarchical structure. These elements correspond to fields of the data item. Each element has a name, sometimes called a tag. Each element also has a value, but sometimes this is a null value. For example, an element with the name **APID** begins with the tag **<APID>** followed by the value of the element and ends with the tag **</APID>**. If no value is provided (i.e. the value is null) then XML syntax allows the shortcut tag **<APID/>** as an alternative to **<APID></APID>.**

Because of the hierarchical structure, elements may contain other elements, so that tags may be nested.

An attribute is a keyword-value pair contained within the XML brackets for a given tag. For example, changeType and relativePath are attributes below:

    <File changeType="Updated" relativePath="CmdXML/ICDH/ICIC_SUSPEND.XML"/>

    <File changeType="Added" relativePath="PktXML/PKT0955.XML">.

Each XML-based data type is implemented by a **schema,** which defines its semantics. The schema specifies which elements may appear in a data item of the given type, the hierarchical structure and order in which they may appear, the number of times a particular type of element may appear, and constraints on the value of particular elements, such as data type and range limits. The schema enables automatic verification of the syntax and semantics of a data item using general-purpose tools. XML includes a special language, called XML Schema, for defining schemas.

The XML family of standards includes the Extensible Stylesheet Language for Transformations (XSLT). XSLT can be used to transform XML documents into other formats for use in local applications.

More information regarding XML, XML schema, and XSLT is available at http://www.w3.org.

5.   PRD DATA TYPE DEFINITIONS

5.1   OVERVIEW

This section provides the interface **design** via a complete human-readable definition of each data type supported in the PRD (Table 3-1). For each XML-based data type, the PRD MO has defined a schema providing the formal, machine-readable interface **definition** that corresponds to this design. For non-XML data types, such as proprietary ASCII and binary data, files are accepted into PRDS as DFCD-verified by the data item owner.

PRD users need to be aware of the different purposes of these representations. The **text definition** is provided for readability and is the main vehicle for DFCD review. It also provides an independent specification for the interface definition (elements and constraints on those elements) to be enforced by the schemas. This will be used by PRDS testers in verifying the schemas, which in turn will be used to verify PRD content.

The **schema** is code that defines the exact form of the XML-based data that the PRDS will accept. Schemas based on this DFCD are incorporated into the PRDS to support automated data verification. The schemas for XML-based data types in this DFCD are delivered with each officially published PRD. Tools developed to translate PRD content alternate formats will use the schema for interface definitions.

5.1.1   Data Definition Standards

For each XML-based data type, the text definition must provide the following information:

- The name of the top-level XML tag used to encapsulate data items of that type.

- A list of the names (tags) of all valid element types (fields) accepted as part of the data type.

- A description of the purpose and usage of each element. For string elements restricted to a list of predefined legal values, a brief description of each legal value should be provided.

- The hierarchical structure and order in which elements may appear.

- The number of times each type of element may appear within a data item.

- The data class (i.e., integer, floating point, string) of each element.

- The integer values used throughout this document use a decimal format unless specifically stated otherwise.

- For numeric elements, any limits on the range of the element.

- For string elements, any limits on the length of the string, accepted legal values, and the types of characters allowed (e.g., case restrictions, alphabetic vs. numeric characters, special characters).

- Any constraints among elements within a particular data item (for example, a particular value of element A may not make sense in conjunction with a particular value of element B).

- Any constraints on elements across multiple data items (for example, a set of elements that are used to identify the data item and must be unique).

Schema verification of XML-based data types will be performed as part of PRDS verification. This process must ensure that the schema enforces all constraints specified as part of the text data definition that rely only on information from a particular data item. Constraints involving multiple data items must also be verified, but these will be flowed down to the PRDS auditing capability rather than the schema.

The term "white space" in these ASCII fields refers to tabs, spaces, linefeeds, and carriage controls. In general, embedding white space within field values is not good practice except for free-form descriptive text fields. A field value is considered null when the element (tag name) is provided but the value is unspecified.

Upper case characters are the capital letters A to Z; lower case characters are the small letters a to z.

The following special characters are not allowed within text fields: '<', '>', and '&'.

This document uses the Consultative Committee on Space Data Systems (CCSDS) bit and byte numbering convention. The first and leftmost byte or bit of each data element portrayed will be numbered as byte or bit zero and will be considered the most significant byte or bit. For the purposes of this document, the term **byte** always refers to eight associated bits, and the term **word** refers to sixteen associated bits (two associated bytes).

For the purpose of addressing bits in the command and telemetry CCSDS packets in this DFCD all positions, unless specifically specified otherwise, are relative to the start of the packet whose first bit has an offset of zero. For illustration purposes, the following examples utilize the packet constructs utilized by a previous mission.

The command depicted in Figure 5-1 would have an offset of 64 and the command in Figure 5-2 would have an offset of zero. The first bit in the telemetry user area is 112 for real-time telemetry. Lengths of fragments of packets whether specified in bits or bytes are, of course, cardinal numbers beginning with the number one. Because some instrument commands must end on a 16-bit word boundary, their packet length in bytes for the cases Figures 5-1 and 5-2 can range between 8 to 1016 and 2 to 1016, respectively, and specified as even cardinal numbers (See Section 5.2 for details). Telemetry uses 8-bit words and the packet length can range from 15 to 1088 for this example and specified as either even or odd cardinal numbers.

| PRIMARY HEADER | | | | | | | SECONDARY HEADER | | |
VERSION	TYPE	SEC HEADER FLAG	APPLIC. PROCESS ID	SEQUENCE FLAGS	SOURCE SEQUENCE COUNT	PACKET DATA LENGTH	NOT USED	FUNCTION CODE	USER DATA
	PACKET IDENTIFICATION			PACKET SEQUENCE CONTROL					
3 Bits	1 Bit	1 Bit	11 Bits	2 Bits	14 Bits	16 Bits	8 Bits	8 Bits	1009 Octets Max

Figure 5-1. CCSDS Packet Layout for Command header type SH
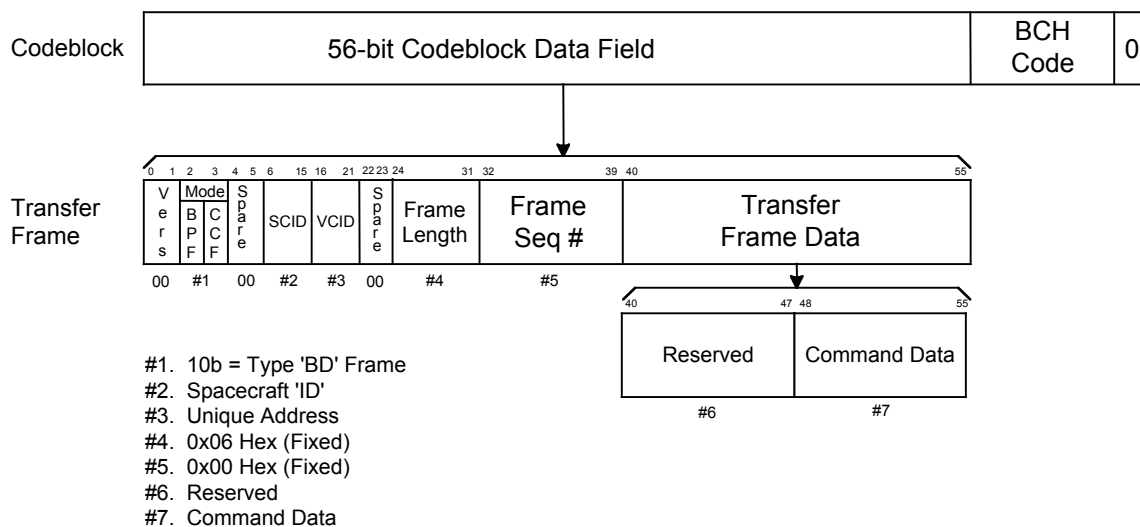
Figure 5-2. CCSDS Packet Layout for Command header type TF

| PRIMARY HEADER | | | | | | | SECONDARY HEADER | |
VERSION	TYPE	SEC HEADER FLAG	APPLIC. PROCESS ID	SEQUENCE FLAGS	SOURCE SEQUENCE COUNT	PACKET DATA LENGTH	CCSDS DAY SEGMENTED	USER DATA
	PACKET IDENTIFICATION			PACKET SEQUENCE CONTROL				
3 Bits	1 Bit	1 Bit	11 Bits	2 Bits	14 Bits	16 Bits	64 Bits	1074 Octets Max

Figure 5-3. CCSDS Packet Layout for Real-Time Telemetry

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5.1.2 Data Definition Format

Each XML-based data definition (for a given data type) consists of a table that summarizes the valid fields (element types), followed by a detailed description of each field. By convention, the detailed description is complete by itself; the table is only a convenient reference. The tables have the following columns:

Field #: A numeric identifier for the field, which is referenced later in the detailed description. To show the hierarchical structure, fields contained within other fields are identified with a sub-numbering scheme. For example, if field 5 has three fields contained within it, these would be numbered 5.1, 5.2, and 5.3. If field 5.3 contains two subfields of its own, these would be numbered 5.3.1 and 5.3.2, and so on.

Field Name: The name of the XML tag that identifies the element. By convention, subfield names are indented relative to parent fields to show the hierarchical structure.

Data Class: An indication of whether the field is integer, floating point, character string, or URL (Web address).

Range/Length: For numeric fields, this gives the minimum and maximum values. For character string fields, this gives the valid range for length of the string.

Occurrences: This gives the minimum and maximum number of times the element may occur. If the minimum is 0, the element is optional. For example, "0-8" means the element is optional and may occur up to 8 times. A single number (usually 1) means that the number of occurrences is fixed.

For "container" fields (fields that represent a container for subfields), the "data class" and "range/length" information does not apply and is normally replaced by the string "Parent container". Note that regardless of the legal number of occurrences, subfields of a container field are only allowed if the parent container field is provided.

5.2   COMMANDS

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5.3   TELEMETRY DEFINITIONS

(Page intentionally left blank)

5.4   PACKET DEFINITIONS

(Page intentionally left blank)

5.5   CONVERSIONS

(Page intentionally left blank)

5.6   DATABASE VERSION NAME

(Page intentionally left blank)

5.7   SUBSYSTEM LIST

(Page intentionally left blank)

5.8   REAL-TIME PROCEDURES

(Page intentionally left blank)

5.9   SYSTEM DISPLAYS

(Page intentionally left blank)

5.10   WORKSPACES

(Page intentionally left blank)

5.11   DISPLAY HEADER TEMPLATES

(Page intentionally left blank)

5.12   DISPLAY PAGES

(Page intentionally left blank)

5.13   OBSERVATORY FSW DEFINITIONS

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5.14   OBSERVATORY LOAD TEMPLATES

(Page intentionally left blank)

5.15   COMMAND APID DESCRIPTIONS

(Page intentionally left blank)

5.16   FOT FSW TABLES

(Page intentionally left blank)

5.17 FSV FSW TABLES

(Page intentionally left blank)

5.18 DERIVED PARAMATER DEFINITIONS

(Page intentionally left blank)

5.19 GROUND SYSTEM DATA DEFINITIONS

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5.20 ATS / RTS DEFINITIONS

(Page intentionally left blank)

5.21 EGSE DIRECTIVES

(Page intentionally left blank)

5.22 EGSE TELEMETRY DEFINITIONS

(Page intentionally left blank)

5.23 EGSE SCRIPTS

(Page intentionally left blank)

5.24 GROUP PERMISSIONS

(Page intentionally left blank)

5.25 USER/WORKSTATION PERMISSIONS

6.   PRD TO APPLICATION DATA TYPE CORRELATIONS & TRANSLATIONS

6.1   OVERVIEW

This section provides the interface **design** via a complete human-readable definition of each data type supported in the PRD (Table 3-1). For each XML-based data type, the PRD MO has defined a schema providing the formal, machine-readable interface **definition** that corresponds to this design. For non-XML data types, such as proprietary ASCII and binary data, files are accepted into PRDS as DFCD-verified by the data item owner.

7. PRD INTERFACE DETAILED DEFINITIONS

7.1 OVERVIEW

This section defineds the interface control details for the PRD system utilities.

7.2 CHANGE REQUEST BUNDLE FORMAT

Change Request Bundle file is a Zip file (archive) containing the files listed in Table 7-1. Descriptions of these files are provided below. A Change Request (CR) may be opened in the PRDS Change Request System by submitting a bundle. One bundle is permitted per CR. Other information may be added to the CR once it is open using the CR System options for modifying a CR.

Table 7-1. Change Request Bundle Format

File	Format	Occurrences
CR_DESCRIPTION.XML	XML	1
PRD Data Item(s)	Defined in this document	1 – 20,000
Auxiliary file(s)	Any	0 – 10

The format for the CR_DESCRIPTION.XML file in given in Table 7-2. Each CR description file begins with the tag <CrDescription> and ends with the tag </CrDescription>.

Table 7-2. CR Description File Format

Field #	Field Name	Data Class	Range/Length	Occurrences
1	<Title>	char	1 – 80	1
2	<Description>	char	1 – 3000	1
3	<Comments>	char	0 – 3000	1
4	<File>	null	null – see attributes	1 – 20,000
4 Attribute	changeType	char	See below	1
4 Attribute	relativePath	char	See below	1
5	<ChangeRequestFormatVersion>	uint	1	1

Detailed Field Descriptions:

1. <Title> - The Change Request Title is a brief description of the change request and will be used in reports for PRD publications. One instance is required. This field consists of 1 to 80 characters.

2. <Description> - The description field consists of 1 to 3000 characters. This field should be used to describe in detail what changes are being made, why they are being made, whether there are any scheduling constraints, etc. One instance is required.

3. <Comments> - The comments field consists of 0 to 3000 characters. When the CR is opened, the comments will be listed under a separate heading. Supplementary information may be provided here. One optional instance is allowed.

4. <File> - This provides required information for the PRD data items included in the CR bundle. One to 20,000 instances are allowed. This information is given in the following attributes.

    changeType – this required attribute describes the whether the file is Added, Updated or Removed, which is provided within quotes, e.g. changeType="Added". Specify Added if the data item is new. Specify Updated if the data item is being modified. Specify Removed if the data item is to be deleted from the PRD.

    relativePath – this required attribute gives the location of the data item within the PRD. The value provided must follow the format DataType/Subsystem/DataItemFileName

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Where:

DataType is listed in Table 3-2 under Level 1

Subsystem is listed in Table 3-3 Secondary Subdirectory Structures. The subsystem must match the appropriate Data Type as listed under Level 2 in this table. Some data types do not have subsystems, in which case the field is blank (use one slash "/" character between DateType and DataItemFileName).

DataItemFileName provides the name of the file for the specified data item. Naming conventions for each data type are defined in this DFCD.

5. <ChangeRequestFormatVersion> - This is an integer specifying the Nth format definition version for the change request bundle file. One instance is required. The value is 1 (one) since this is the first version defined. The value will be utilized by the PRDS software. If the format is changed, the version number should be incremented.

The PRD Data Items included in the bundle must conform to the formats described in this DFCD. Only include data items in the bundle if they are added or updated. In addition, each PRD Data Item added or updated in the bundle must be listed in the CR_DESCRIPTION.XML file. The data item is not included in the bundle if it is to be removed (changeType="Removed"), but such files must be specified in CR_DESCRIPTION.XML file.

The Auxiliary file(s) are other files pertinent to the change request but are not PRD Data Items. Examples include text, jpeg, Microsoft Office and Adobe documents. Auxiliary files are optional. When present, auxiliary files must be located in a folder with the relative path equal to auxiliary_info. Up to ten files are allowed in the bundle. Additional auxiliary files may be added to the CR later using the CR System options for modifying a CR.

7.3 CERTIFICATION PACKAGE BUNDLE FORMAT

The bundle format is designed to allow the submission of either PRD Test certification information or PRD Waiver information. The PRD data items may be Flight Operations CCB published data and/or data included in an unpublished Change Request filed in the Change Request System.

The Certification Package file is a Zip file (archive) containing the files listed in Table 7-3. Descriptions of these files are provided below. A Certification Package (CP) may be attached to a PRDS Change Request using the CR System options for modifying a CR.

Table 7-3. Certification Package Format

File	Format	Occurrences
CP_DESCRIPTION.XML	XML	1

Auxiliary file(s)	Any	0 – 100

The format for the CP_DESCRIPTION.XML file is given in Table 7-4. Each CP description file begins with the tag <CpUnit> and ends with the tag </CpUnit>.

The CP Description Format is still under review and may need to be updated in the future.

Table 7-4. CP Description Format

Field #	Field Name	Data Class	Range/Length	Occurrences
1	<CpTitle>	char	1 – 80	1
2	<CpDescription>	char	1 – 3000	1
3	<CertificationType>	char	See below	1
4	<CertificationDate>	Parent container		1
4.1	<Year>	uint	=> 2006	1
4.2	<Month>	uint	1 – 12	1
4.3	<Date>	uint	1 – 31	1
5	<BaselinePrdVersionIdentifier>	char	1 – 25	1
6	<Certifier>	Parent container		1
6.1	<FirstName>	char	1 – 20	1
6.2	<LastName>	char	1 – 30	1
6.3	<FunctionalTitle>	char	1 – 80	0 – 1
6.4	<Organization>	char	1 – 80	0 – 1
6.5	<EmailAddress>	char	1 – 80	1
7	<TestInformation>	Parent container		0 – 1
7.1	<TestName>	char	1 – 80	1
7.2	<TestDate>	Parent container		1
7.2.1	<Year>	uint	=> 2006	1
7.2.2	<Month>	uint	1 – 12	1
7.2.3	<Date>	uint	1 – 31	1
7.3	<Facility>	char	6 – 80	1

Field #	Field Name	Data Class	Range/Length	Occurrences
7.4	\<TestDescription>	char	6 – 80	1
7.5	\<CertificationLevel>	uint	2 – 3	1
7.6	\<Tester>	Parent container		1
7.6.1	\<FirstName>	char	1 – 20	1
7.6.2	\<LastName>	char	1 – 30	1
7.6.3	\<FunctionalTitle>	char	1 – 80	0 – 1
7.6.4	\<Organization>	char	1 – 80	0 – 1
7.6.5	\<EmailAddress>	char	1 – 80	1
8	\<WaiverInformation>	Parent container		0 – 1
8.1	\<Justification>	char	1 – 10000	1
8.2	\<Approver>	Parent container		1
8.2.1	\<FirstName>	char	1 – 20	1
8.2.2	\<LastName>	char	1 – 30	1
8.2.3	\<FunctionalTitle>	char	1 – 80	0 – 1
8.2.4	\<Organization>	char	1 – 80	0 – 1
8.2.5	\<EmailAddress>	char	1 – 80	1
8.3	\<ApproverComments>	char	1 – 10000	1
8.4	\<ApprovalDate>	Parent container		1
8.4.1	\<Year>	uint	=> 2006	1
8.4.2	\<Month>	uint	1 – 12	1
8.4.3	\<Date>	uint	1 – 31	1
9	\<RecertifiedBaselineDataItems>	Parent container		0 – 1
9.1	\<DataItem>	Parent container		1 – 20000
9.1.1	\<Datatype>	char	3 – 32	1
9.1.2	\<Subsystem>	char	3 – 32	0 or 1
9.1.3	\<FileName>	char	3 – 32	1
10	\<NewOrModifiedDataItems>	Parent container		0 – 1
10.1	\<DataItem>	Parent container		1 – 20000

Field #	Field Name	Data Class	Range/Length	Occurrences
10.1.1	<Datatype>	char	3 – 32	1
10.1.2	<Subsystem>	char	3 – 32	0 or 1
10.1.3	<FileName>	char	3 – 32	1
11	<CertificationPackageFormatVersion>	uint	1	1

Detailed Field Descriptions:

1.   **<CpTitle> -** A string up to 80 characters that is the title of the certification package. One instance is required.

2.   **<CpDescription>** - Contains general information about the certification package with a maximum of 3000 characters. One instance is required.

3.   **<CertificationType>** - A string that has the value of either "Test" or "Waiver" indicating whether the certification is based on the performance of a certification test or is based on the approval of a waiver to certify PRD Data Items without performing a certification test. One instance is required.

4.   **<CertificationDate>** - The parent container that identifies the date of the certification. One instance is required.

    4.1   **<Year>** - An integer greater than or equal to 2006 providing the year of the certification. One instance is required.

    4.2   **<Month>** - An integer from 1 to 12 providing the month of the certification. One instance is required.

    4.3   **<Date>** - An integer from 1 to 31 providing the valid date of the month of the certification. One instance is required.

5.   **<BaselinePrdVersionIdentifier>** - A string from 1 to 25 characters that specifies the baseline PRD version of the context in which the data items listed in this certification package are certified. The baseline indicates a PRD version published by the Flight Operations CCB. One instance is required.

6.   **<Certifier>** - This is a required parent container that identifies the certifier of the PRD data items listed in the package. One instance is required.

    6.1   **<FirstName>** – The first name of the certifier. (required)

    6.2   **<LastName>** – The last name of the certifier. (required)

    6.3   **<FunctionalTitle>** – The job title of the certifier. (optional)

6.4   **<Organization>** – The home institution of the certifier. (optional)

6.5   **<EmailAddress>** - The email address of the certifier (required)

7.   **<TestInformation>** - This is the parent container for information about the test performed to certify the data items in this certification package. It is required if the <WaiverInformation> tag is not present, but is not allowed if the <WaiverInformation> tag is present.

7.1   **<TestName>** - A string from 1 to 80 characters that is the name of the test performed to certify the data items in this certification package. One instance is required.

7.2   **<TestDate>** - The parent container that identifies the date of the test. One instance is required.

7.2.1   **<Year>** - An integer greater than or equal to 2006 providing the year of the certification. One instance is required.

7.2.2   **<Month>** - An integer from 1 to 12 providing the month of the certification. One instance is required.

7.2.3   **<Date>** - An integer from 1 to 31 providing the valid date of the month of the certification. One instance is required.

7.3   **<Facility>** - A string from 6 to 80 characters that identifies the LDCM facility or location where the test was performed. One instance is required.

7.4   **<TestDescription>** - A string from 6 to 80 characters that identifies the test method or equipment used. Once instance is required.

7.5   **<CertificationLevel>** - An integer indicating the level of testing: 2 if tested with a simulator, test tool or analysis; 3 if tested directly with flight hardware. One instance is required.

7.6   **<Tester>** - Required parent container that identifies the tester. One instance is required.

7.6.1   **<FirstName>** – The first name of the tester. (required)

7.6.2   **<LastName>** – The last name of the tester. (required)

7.6.3   **<FunctionalTitle>** – The job title of the tester. (optional)

7.6.4   **<Organization>** – The home institution of the tester. (optional)

7.6.5   **<EmailAddress>** - The email address of the tester (required)

8.   **<WaiverInformation>** - This is the parent container for information about the waiver used to certify the data items in this certification package. It is required if the <TestInformation> tag is not present, but is not allowed is the <TestInformation> tag is present.

8.1   **<Justification>** - A string from 1 to 10000 characters containing the justification for certifying the data items in this certification package. One instance is required.

8.2   **<Approver>** - This is the parent container that identifies the person that authorized approval of the waiver to certify the data items in this certification package. One instance is required.

   8.2.1   **<FirstName>** – The first name of the approver. (required)
   8.2.2   **<LastName>** – The last name of the approver. (required)
   8.2.3   **<FunctionalTitle>** – The job title of the approver. (optional)
   8.2.4   **<Organization>** – The home institution of the approver. (optional)
   8.2.5   **<EmailAddress>** - The email address of the approver. (required)

8.3   **<ApproverComments>** - A string from 1 to 10000 characters containing comments from the approver explaining acceptance of the waiver to certify the data items in this certification package. One instance is required.

8.4   **<ApprovalDate>** - The parent container that identifies the date of the approval. One instance is required.

   8.4.1   **<Year>** - An integer greater than or equal to 2006 providing the year of the certification. One instance is required.

   8.4.2   **<Month>** - An integer from 1 to 12 providing the month of the certification. One instance is required.

   8.4.3   **<Date>** - An integer from 1 to 31 providing the valid date of the month of the certification. One instance is required.

9.   **<RecertifiedBaseLineDataItems>** - This is the parent container for the list of data items unchanged in the baseline PRD (<BaselinePrdVersionIdentifier>) that have been recertified in this certification package. One optional instance is allowed.

   9.1   **<DataItem>** - This parent container specifies an unchanged data item certified in this certification package with the following attributes. 1 to 20000 instances are allowed.

      9.1.1   **<Datatype>** – The data type of the data item, as specified in Table 3-2 under Level 1 (required)
      9.1.2   **<Subsystem>** – The subsystem of the data item, as specified in Table 3-3 Secondary Subdirectory Structures. The subsystem, if applicable, must match the appropriate Data Type as listed under Level 2 in this table. (optional)
      9.1.3   **<FileName>** – The file name of the data item. Naming conventions for each data type are defined in this IRCD. (required)

10. **<NewOrModifiedDataItems>** - This is the parent container for the list of data items that are new or modified from the baseline PRD (<BaselinePrdVersionIdentifier>) that have been certified in this certification package. One optional instance is allowed.

10.1 **<DataItem>** - This parent container specifies a new or modified data item certified in this certification package with the following attributes. 1 to 20000 instances are allowed.

    10.1.1 **<Datatype>** – The data type of the data item, as specified in Table 3-2 under Level 1 (required)

    10.1.2 **<Subystem>** – The subsystem of the data item, as specified in Table 3-3 Secondary Subdirectory Structures. The subsystem, if applicable, must match the appropriate Data Type as listed under Level 2 in this table. (optional)

    10.1.3 **<FileName>** – The file name of the data item. Naming conventions for each data type are defined in this IRCD. (required)

11. **<CertificationPackageFormatVersion>** - This is an integer specifying the Nth format definition version for the certification package zip file. One instance is required. The value is 1 (one) since this is the first version defined. The value will be utilized by PRDS software. If the format is changed, the version number should be incremented.

The Auxiliary file(s) are other files pertinent to the certifications of the PRD Data Items. Auxiliary files are optional. When present, auxiliary files must be located in a folder with the path equal to auxiliary_info. Up to one hundred files are allowed.

APPENDIX A   ABBREVIATIONS AND ACRONYMS

ACS	Attitude Control System
APID	Application Process Identifier
ASCII	American Standard Code for Information Interchange
ASTM	American Society of Testing and Materials
bMOC	Backup Mission Operations Center
CAPE	Collection Activity Planning Element
CCB	Configuration Control Board
CCSDS	Consultative Committee for Space Data Systems
CDH	Command and Data Handling
C/TWS	Command and Telemetry WorkStation
COP	Command Operations Protocol
CR	Change Request
CTP	Command and Telemetry Processor
DFCD	Data Format Control Document
DIRD	Data Interface Requirements Document
DN	Data Number
DPAS	Data Processing and Archive Segment
EU	Engineering Unit
FARM	Frame Acceptance and Reporting Mechanism
FGS	Fine Guidance Subsystem
FOS	Flight Operations Segment
FPA	Focal Plane Assembly
FSW	Flight Software
GNE	Ground Network Element
I&T	Integration and Test
ICD	Interface Control Document
IE	Infrastructure Element
IEEE	Institute of Electrical and Electronics Engineers
IPE	Image Processing Element
LDCM	Landsat Data Continuity Mission
LDF	Load Data Files
MOC	Mission Operations Center
MOE	Mission Operations Element
MOU	Memorandum of Understanding
MS	Microsoft
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NPR	NASA Procedural Requirements
OLI	Operational Land Imager
PRD	Project Reference Database
PRDS	Project Reference Database Subsystem
PSLA	Project Service Level Agreement

SAE	Storage & Archive Element
STScI	Space Telescope Science Institute
T&C	Telemetry & Command
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Specified
UML	Unified Modeling Language
UPE	User Portal Element
VCDU	Virtual Channel Data Unit
VCID	Virtual Channel Identifier
VCS	Version Control System
VDD	Version Description Document
XML	eXtensible Markup Language
XREF	Cross-Referencing System
XSLT	XML Stylesheet Language for Transformations

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APPENDIX B